United Kingdom of Great Britain and Northern Ireland

EDICT OF GOVERNMENT

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BS NA EN 1993-1-11 (2006) (English): UK National Annex to Eurocode 3. Design of steel structures. Design of structures with tension components

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NA to BS EN 1993-1-11:2006

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Part 1-11: Design of structures with tension components

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Summary of pages
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National Annex (informative) to BS EN 1993-1-11:2006, Eurocode 3: Design of steel structures – Part 1-11: Design of structures with tension components

Introduction

This National Annex has been prepared by BSI Subcommittee B/525/10, *Bridges*, in consultation with B/525/31, *Structural use of steel*. In the UK it is to be used in conjunction with BS EN 1991-1-11:2006.

NA.1 Scope

This National Annex gives:

a) the UK decisions for the Nationally Determined Parameters described in the following subclauses of BS EN 1993-1-11:2006:

- **2.3.6**(1)
- **2.3.6**(2)
- **2.4.1** (1)
- **3.1** (1)
- **4.4**(2)
- **4.5**(4)
- **5.3**(2)
- **6.2**(2)
- **6.3.2**(1)
- **6.3.4**(1)
- **6.4.1**(1)P
- **7.2**(2)
- **A.4.5.1**(1)
- **A.4.5.2**(1)
- **B**(6)

b) the UK decisions on the status of BS EN 1991-1-11:2006 informative annexes; and

c) references to non-contradictory complementary information.

NA.2 Nationally Determined Parameters

NA.2.1 Replacement and loss of tension components [BS EN 1993-1-11:2006, 2.3.6]

(1) NOTE

During replacement of tension components, all elements of the structure should satisfy the relevant serviceability and ultimate limit state requirements without any restrictions to traffic or other imposed loads, unless specified otherwise in the Project Specification.

If restrictions to traffic and other imposed loads are considered, the restrictions measures should be detailed in the Project Specification.

For ultimate limit states, the load factors and combination factors in the transient situation should be taken to be the same as for the persistent combination.

For serviceability limit states, verifications should be made using the characteristic, frequent or quasi-permanent combination as required by the relevant Eurocode provisions.

(2) NOTE

Unless specified otherwise for specific projects, structures should be designed to accommodate the loss of any one hanger, stay without any restrictions to traffic or other imposed loads. The structure should be designed to satisfy all ultimate limit state requirements in the accidental combination, including the dynamic effect of cable removal in NOTE 2 of **2.3.6**(2).

Where a structure cannot be designed to accommodate the loss of a particular tension component, the Project Specification should specify the protection measures to be adopted to prevent sudden removal of that tension component

NA.2.2 Transient design situation during the construction phase [BS EN 1993-1-11:2006, 2.4.1]

(1) NOTE

The recommended values for γ_{Gi} should be adopted.

NA.2.3 Strengths of steels and wires [BS EN 1993-1-11:2006, 3.1]

(1) NOTE 6

At present there is no limit to the maximum value for f_u. However the current ongoing research might find that extra high strength wire is more susceptible to premature failure. Wires of tensile strengths greater than the recommended maximum value should be agreed and specified in the Project Specification.

NA.2.4 Corrosion protection of the exterior of Group B tension components [BS EN 1993-1-11:2006, 4.4]

(2) NOTE 1

The corrosion resistance class for the stainless steel should be specified for the individual projects.

NA.2.5 Corrosion protection of Group C tension components [BS EN 1993-1-11:2006, 4.5]

(4) NOTE 1

Trials should be undertaken for all fillers. Continuous hydrophobic materials may include soft fillers such as wax or soft resin. Grease can be subject to problems of thermal stability; it should not therefore be used without a suitable verification of thermal stability. Hard fillers, such as cement grout should not be used.

NA.2.6 Transient construction phase [BS EN 1993-1-11:2006, 5.2]

(3) NOTE

The recommended values for γ_P should be adopted.

NA.2.7 Persistent design situation during service [BS EN 1993-1-11:2006, 5.3]

(2) NOTE

Combination of P and G into a single action (G + P) is not appropriate for cable-stayed bridges with stiff decks, externally post-tensioned bridges and guyed towers and masts, because normal site monitoring of deflections and adjustment of cables will be insufficient to guarantee that there is no significant unintended imbalance between G and P.

The aforementioned structures are therefore not within the scope of BS EN 1993-1-11:2006, **5.3**. If the rules of BS EN 1993-1-11 are applied to such structure types it is suggested that the actions P and G should have partial factors applied to them separately as required in **5.2**(3). In such cases the project specification should give the values of γ_G and γ_P that are to be used.

NA.2.8 Prestressing bars and Group B and C components [BS EN 1993-1-11:2006, 6.2]

(2) NOTE 4

The recommended values for γ_R in Table 6.2 should be adopted.

NA.2.9 Slipping of cables over saddles [BS EN 1993-1-11:2006, 6.3.2]

(1) NOTE

The recommended value for $\gamma_{M,fr}$ should be adopted.

NA.2.10 Design of saddles [BS EN 1993-1-11:2006, 6.3.4]

(1) NOTE

The recommended value for k should be adopted.

NA.2.11 Slipping of cables over saddles [BS EN 1993-1-11:2006, 6.4.1]

(1)P NOTE 1

The recommended value for $\gamma_{M,fr}$ should be adopted.

NA.2.12 Stress limits [BS EN 1993-1-11:2006, 7.2]

(2) NOTE 1

The recommended values for f_{const} in Table 7.1 and f_{SLS} in Table 7.2 should be adopted.

NA.2.13 Waterproofing [BS EN 1993-1-11:2006, A.4.5.1]

(1) NOTE

The tension components should be tested for watertightness in accordance with article 11.3 of *SETRA Cable Stays* [1] unless an alternative test is specified in the Project Specification.

NA.2.14 Corrosion protection barriers [BS EN 1993-1-11:2006, A.4.5.2]

NOTE

Test requirements for protective void fillers for Group C tension components, individual HDPE sheaths and outer stay pipes are given in Table NA.1 and Table NA.2.

Table NA.1 **Protective void filler for Group C tension components**

Character specified	Value specified	Test method
Pour point	> 77 °C	ISO 2207
Penetration at –20 °C	No cracking	ASTM 937
Penetration at 25 °C	< 80/10 mm	ASTM D217
Viscosity at 100 °C	> 20 mm^2/s	ASTM D445-06
Bleeding at 40 °C	At 7 days <0.5%	BS 2000-121 modified by conducting the test for 7 days without the 100 g weight
Oxidative resistance, 100 h at 100 °C	<0.03 MPa	ASTM D942
Copper strip corrosion, 100 h at 100 °C	Level 1a (no corrosion)	BS EN ISO 2160:1998
Rust protection		
• Salt fog: 5% NaCl, 168 h at 35 °C ± 1 °C	Pass	BS EN ISO 9227
• Fog: distilled water, 168 h at 35 °C ± 1 °C	No corrosion	BS EN ISO 9227

Individual HDPE sheaths

Individual HDPE sheaths should be formed from high-density polyethylene. The minimum physical and mechanical properties should be as given in Table NA.2.

Outer stay pipes

HDPE stay pipes should consist of bi-extruded high-density polyethylene tubes, with minimum physical and mechanical properties as given in Table 2 and ASTM D3350. HDPE pipes should be provided with a contoured surface or a helical up stand to reduce wind and wind/rain oscillation.

The minimum duct thickness as follows:

Duct thickness of at least $\Phi_{ext}/12$ or 5 mm, whichever is greater.

When tubes are hot-plate welded together:

Duct thickness of at least $\Phi_{ext}/50$ or 4 mm, whichever is greater.

Table NA.2 **Properties of HDPE sheaths and stay pipes**

Head	Head	Head
Character specified	**Value specified**	**Test method**
Density at 23 °C	>950 kg/m^3	BS EN ISO 1183-2
Melt flow index of 5 kg at 190 °C	<0.15 g per 10 min	BS EN ISO 1133
Flexural modulus	>800 MPa on average	BS ISO 178
Tensile stress at yield point at 23 °C	19 MPa	BS EN ISO 527-3
Ultraviolet radiation stability	Condition E	ASTM D3350
Carbon-black content (inner layer only in the case of a co-extruded stay pipe)	2.3% ± 0.3% by weight	ISO 6964
Carbon-black dispersion index	<3	ISO 4437
Carbon-black distribution level	<C2	ISO 4437
Anti-oxidant content in the final composition of the HDPE	>1000 ppm	
Thermal stability	>220 °C for 20 minutes	ASTM D3350
Oxidative induction time at 200 °C	>20 minutes	BS EN 10837 or ASTM D3350
Elongation at fracture	500% – HDPE sheaths 350% – Stay pipes	BS EN ISO 527-3
Izod impact strength at 23 °C	>20 kJ/m^2	BS EN ISO 180
Stress cracking resistance at stress F 50	>1000 h	ASTM 1693, condition B
Shore D hardness	>55 points	BS EN ISO 868

NA.2.15 Annex B – Transport, storage, handling

(6) NOTE

Monitoring might be required to confirm that the design assumptions, such as final forces in tension components and vibration of tension components due to wind, rain and traffic, have been met in the completed structure. The Project Specification should specify the required monitoring regime and its duration.

Suitable monitoring includes:

a) Wind monitoring equipment (anemometers and wind direction).

b) Load indicators to record cable stay loads.

c) Bi-directional accelerometers on the free length of cables to assess vibration.

d) Acoustic monitoring.

Details of maintenance procedures should be provided which should include at least:

- Procedures for minor and major maintenance operations expected during the design lifetime of the tension components;
- The replacement procedure for a tension component in accordance with the design assumptions made in the Project Specification.

NA.3 Decision on the status of informative annexes

Informative annexes A, B, C should be used.

NA.4 References to non-contradictory complementary information

SETRA, Cable Stays – Recommendations of French Interministerial Commission on Prestressing (2002), France [1].

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Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 2000-121, *Methods of test for petroleum and its products – Part 121: Determination of oil separation from lubricating grease – Pressure filtration method*

BS EN ISO 180, *Plastics – Determination of Izod impact strength*

BS EN ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

BS EN ISO 868, *Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)*

BS EN ISO 1133, *Plastics – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

BS EN ISO 1183-2, *Plastics – Methods for determining the density of non-cellular plastics – Part 2: Density gradient column method*

BS EN ISO 2160:1998, *Petroleum products – Corrosiveness to copper – Copper strip test*

BS EN ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests*

BS ISO 178, *Plastics – Determination of flexural properties*

ISO 2207, *Petroleum waxes – Determination of congealing point*

ISO 4437, *Buried polyethylene (PE) pipes for the supply of gaseous fuels – Metric series – Specifications*

ISO 6964, *Polyolefin pipes and fittings – Determination of carbon black content by calcination and pyrolysis – Test method and basic specification*

ISO/TR 10837, *Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings*

ASTM D217, *Standard Test Methods for Cone Penetration of Lubricating Grease*[1)]

ASTM D445-06, *Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)*[1)]

ASTM D942, *Standard Test Method for Oxidation Stability of Lubricating Greases by the Oxygen Bomb Method*[1)]

ASTM D1693-07, *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*[1)]

ASTM D3350, *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*[1)]

1) Available from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA; http://www.astm.org.

Other publications

[1] SETRA, Cable Stays – Recommendations of French Interministerial Commission on Prestressing (2002), France.

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